A COMPARISON OF FLASHED WHITE AND INFRARED ILLUMINATION FOR PHOTOGRAPHIC OBSERVATION OF NOCTURNAL BEHAVIOR OF SHRIMP

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SHRIMP FISHERMEN have learned that the largest pink shrimp (Penaeus duorarum) catches are taken during darkness. Adult shrimp usually remain in their burrows during the day and emerge about sunset; they probably forage for food until sunrise, when they burrow again. Nocturnal habits of the pink shrimp have been recorded by a number of workers (Idyll, 1950; Viosca, 1957; Williams, 1958; Eldred et al., 1961; and Fuss, 1964).

Knowledge of the shrimp's burrowing behavior and its response to electrical stimuli has led to the development of an electric shrimp-trawl system (Klima, 1968). Further investigations into the nocturnal behavior of shrimp might lead to greater effectiveness of harvesting gear. However, the use of lights for nighttime observations of this nocturnally active species could adversely bias behavioral data, because pink shrimp exhibit negative photic responses (Fuss and Ogren, 1966).

Because of this negative response to light and the need for additional information about nighttime activities, there is need for a technique whereby nocturnal shrimp behavior can be observed without altering it.

Munz (1965) reported that infrared light is not detected by crustaceans. I have compared the nocturnal activity of shrimp exposed to infrared light with that of shrimp exposed to flashed white light of very short duration. Curious as to the effect of white light of longer duration on the behavior of shrimp, I have compared the activity of shrimp exposed to white light of long duration with the activity level of shrimp exposed to flashed light of short duration.

This is a report on two studies conducted to determine whether a satisfactory photographic method could be developed for observing nighttime activity of shrimp. In the first study, infrared light of 10-second duration and flashed white light of 0.2-millisecond duration were pulsed at 0.5-hour intervals; in the second study, white light of 3.0-second duration and flashed white light of 0.2-millisecond duration were pulsed at 0.5-hour intervals. The infrared and white-light time intervals were selected because they coincided approximately with the time that an observer using either source of light would take to count 10 shrimp in a 50-gallon aquarium. It was assumed that the extremely short exposure (0.2-millisecond) to white light would not affect the behavior of the shrimp. In both studies, two 50-gallon plexiglass aquaria with subsand filters were used as observation chambers. A layer of white sand 11 centimeters deep in each tank permitted the shrimp to burrow. Water temperatures and salinities in the aquaria ranged from 19° to 22° C., and 24 to 29 parts per thousand, respectively.

The shrimp were caught by trawling in St. Andrews Bay, Florida. Short trawl tows were used to minimize injury to the shrimp. After capture, the shrimp were held overnight in a live cage on the sea

floor adjacent to the behavior laboratory to allow for detection of injured animals. Only shrimp that appeared to be in "good physical condition" (that is, apparently without injury or disease) were used for the study.

Ten randomly selected shrimp were used in each day's tests. After 1 night's exposure, the animals were measured and discarded. The animals ranged from 68 to 153 millimeters in total length. The first study lasted 10 nights and involved 100 individuals in each aquarium. The second study lasted 3 nights and involved 30 individuals in each aquarium. Unfortunately, because of the scarcity of shrimp, it was not possible to conduct both studies during the same number of nights.

Automatically controlled 35-millimeter cameras recorded the location of the shrimp at half-hour intervals in the two aquaria. Each tank had a separate light source that was activated at each half-hour interval from 4 hours before sunset until 4 hours after sunrise. The light source, which was assumed not to alter shrimp behavior during both studies, was a photographic electronic 350-watt white flashbulb with a flash of 0.2-millisecond duration. This flash duration was selected because no other available electric flash unit provided a faster light exposure duration. In study 1, light in the infrared spectrum was provided by placing in front of the bulb a filter with 80 percent transmission above 700 millimicrons.[1] Illumination period for the infrared light was 10 seconds. In study 2, the light source was a 1,000-watt incandescent bulb placed 1 meter from the aquarium.

The film sequences permitted detailed analysis of the nocturnal behavior of the two study groups of shrimp at half-hour intervals. Observations of shrimp activity in these two aquaria were compared. All shrimp not burrowed in the sand were considered to be active: this grouping included all shrimp that were swimming, moving about, or motionless on the substrate. At the end of each night, the half-hour intervals of observations of activity for each experimental group were summed and the percentages of active shrimp were calculated; this number was used as an "index of activity."

Because nocturnal shrimp behavior is unknown, I assumed that the highest activity index from each study would approximate normal nocturnal shrimp behavior. I assumed also that photographic observation allowing identification of the magnitude of nightly cyclic trends would be satisfactory. Comparisons of the nightly indexes of activity of these groups, therefore, gave information on the effect of the duration of the light in study 2 and on the effect of the quality of the light in study 1.

In study 1, the activity index was higher for shrimp exposed to 0.2 millisecond of white light than for those exposed to infrared light. Activity of shrimp exposed to the 0.2-millisecond light increased from 26 to 80 percent 1 hour after sunset, held at this level for several hours, and toward midnight decreased to less than 60 percent. A second peak of activity, neither as prolonged nor as pronounced as the first, occurred slightly before dawn. One hour before sunrise, activity decreased rapidly.

Exposure of shrimp to flashed infrared light appeared to affect nocturnal activity (figure 1). Activity increased immediately after sunset, but reached only slightly over the 50-percent level. Thereafter, activity decreased slowly until dawn, when all the shrimp burrowed. The activity level was much greater for shrimp subjected to the strobe light than for those subjected to the flashed infrared light.

In study 2, shrimp subjected to flashed light of 0.2-millisecond duration showed a higher level of nocturnal activity than animals exposed to a white light of 3-second duration (figure 2). Two distinct peaks of activity were observed. The first peak occurred immediately after sunset and reached the 97-percent level; the second occurred just before dawn, and activity reached the 70-percent level. The shrimp exposed to flashed white light of 3-second duration showed less distinct peaks of activity. Immediately after sunset their activity level rose to about 70 percent.

[1] Corning filter No. 2-64. NOTE: Mention of trade name does not imply endorsement.

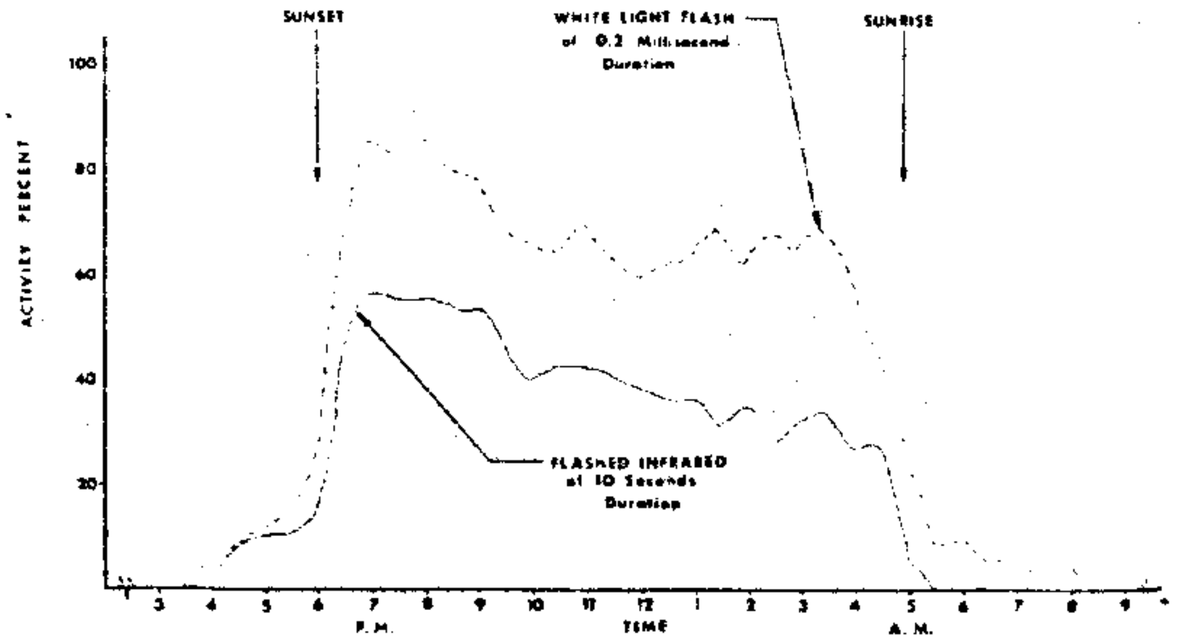

FIGURE 1.--Nocturnal activity of the pink shrimp subjected to flashed infrared light of 10-second duration and flashed white light of 0.2-millisecond duration. (Sample size: 100 shrimp for each group)

The second peak occurred soon after midnight; activity reached almost 30 percent before dawn.

Discussion

Apparently nocturnal behavior of shrimp is not affected appreciably by exposure to white light of 0.2-millisecond duration pulsed at half-hour intervals throughout the night. Perhaps magnitude and duration of activity peaks recorded from field studies made with electronically flashed white light and an automatically controlled 35-millimeter movie camera may be used to indicate cyclic trends in shrimp behavior. Flashed infrared light of 10-second duration and white light of 3-second duration appear to suppress activity levels.

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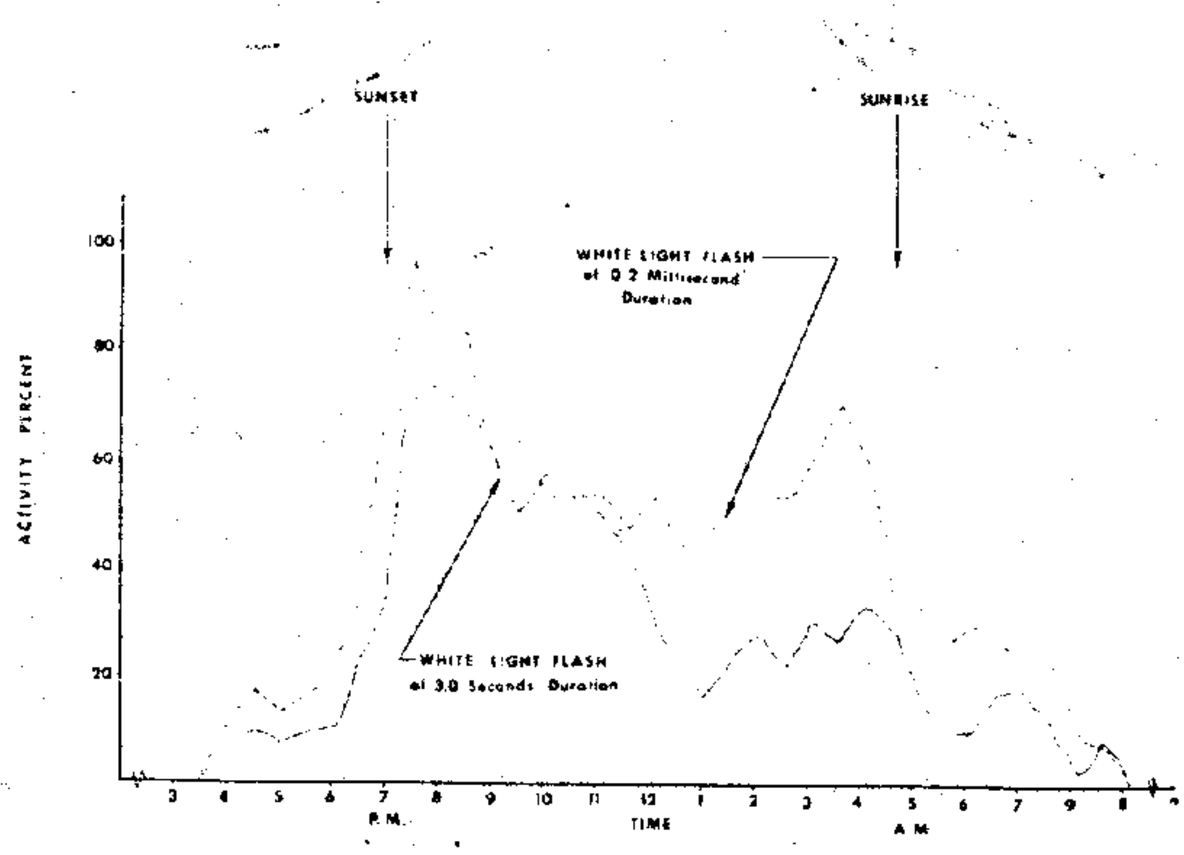

FIGURE 2.--Nocturnal activity of the pink shrimp subjected to flashed white light, 3-second and 0.2-millisecond durations. (Sample size: 30 shrimp for each group)

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